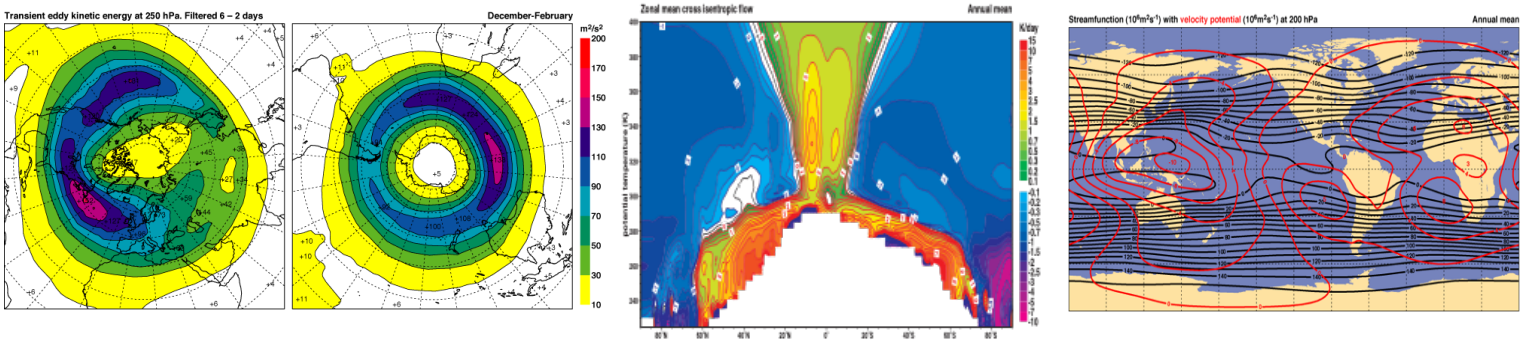
Climate Dynamics 753

The General Circulation of the Atmosphere

DJF kinetic energy [2-6 day time scales] 250hPa | **Heating in Θ [isentropic] Coord.** | **Circulation at 200 hPa ψ and χ**



Figures Courtesy of European Center for Medium Range Weather Forecasts
Kallbert, P. P. Berrisfort, B. Hoskins, A. Simmons, S. Uppala, S. Lamy-Thepaut and R. Hine, 2005. ERA-40 Atlas. ERA-40 Project Report Series No. 19

Course Syllabus Fall 2021

Course Instructor: David M. Straus
(Department of Atmospheric, Oceanic and Earth Sciences)

Instructor Contact:
David Straus Office Hrs Tue-Thur 11AM-1PM or by arrangement
dstraus@gmu.edu

Class location: Exploratory Hall 1005

Class time: Tues and Thurs 3:00 PM to 4:15 PM

- **First class: Tues Aug 24**
- **Last class: Thurs Dec 2**
- **Final Exam: Thurs Dec 9 (1:30 - 4:45 PM)**

Course Goals and Student Learning Outcomes

- **Acquire knowledge of the basic components of the observed atmospheric circulation.**
- **Understand the relationships among these components.**
- **Understand the role of different circulation components in transporting energy and momentum.**
- **Be able to articulate the ways in which the general circulation relates weather phenomena to the climate.**
- **Become familiar with the application of the mathematical theories to the observed circulation.**
- **Acquire basic skills for carrying out original research on the general circulation.**
- **Develop the ability to read current journal papers on the subject, and report the main findings.**

Student Work Components

1. **Four Homework Sets = 33% percent of grade**
2. **Mid-Term and Final Exams = 33% percent of grade**
3. **Computational Project = 33% of grade**

Primary Required Reading (Course Notes):

http://mason.gmu.edu/~dstraus/CLIM_753_syllabus.htm

Supplementary Reading:

- Andrews D.G., J.R. Holton and C.B. Leovy. *Middle Atmosphere Dynamics*. Academic Press, 1987.
- Gill, A.E. *Introduction to Atmosphere-Ocean Dynamics*. Academic Press, 1982.
- Grotjahn, R. *Global Atmospheric Circulations*. Oxford University Press, 1982.
- Haltiner, G.J. and R.T. Williams. *Numerical Prediction and Dynamic Meteorology*. John Wiley & Sons, 1989.
- Masaki, Satoh. *Atmospheric Circulation Dynamics and General Circulation Models*. Springer, 2004.
- James, I.N. *Introduction to Circulating Atmospheres*. Cambridge University Press, 1994.
- Lindzen, R.S. *Dynamics in Atmospheric Physics*. Cambridge University Press, 1990.
- Peixoto, J. and A.H. Oort. *The Physics of Climate*. American Institute of Physics, 1992.
- Salby, Murry L. *Fundamentals of Atmospheric Physics*. Academic Press, 1996.
- Wiin-Nielsen, A. and T.-C. Chen. *Fundamentals of Atmospheric Energetics*. Oxford University Press, 1993.

Reanalysis Data Sets at COLA

- ERA-40 : Sep1957 - Aug2002
- /shared/rean/era40/4xdaily/ctl/era40.ctl (ERA40 upper air 4xdaily data)
- /shared/rean/era40/4xdaily/ctl/era40_sfc.ctl (ERA40 single level 4xdaily data)
- /shared/rean/era40/monthly/ctl/monthly.ctl (ERA40 upper air monthly data)
- /shared/rean/era40/monthly/ctl/monthly_sfc.ctl (ERA40 single level monthly data)
- MERRA : Jan1979 - Dec2000
- /shared/rean/merra/4xdaily/ctl/MERRA100.prod.assim.inst6_3d_ana_Np.ctl (4xdaily)
- MERRA : Jan1979 - Mar2013
- /shared/working/rean/merra/4xdaily/MERRA.prod.assim.inst6_3d_ana_Np.ctl (4xdaily)
- MERRA : Jan1979 - Aug2013
- /shared/rean/merra/monthly/ctl/MERRA.prod.assim.instM_3d_ana_Np.ctl (monthly)
- ERA-Interim : Jan1979 - Dec2012
- /shared/working/rean/era-interim/daily/ctl/pl.ctl (once daily ERA-Interim upper air)
- ERA-Interim : Jan1979 - Dec2012
- /shared/rean/era-interim/monthly/ctl/pl.ctl (monthly ERA-Interim upper air)
- /shared/rean/era-interim/monthly/ctl/sfc.ctl (monthly ERA-Interim single level data)

Course Outline

1. Introduction: Framing the General Circulation.
2. The basic structure of momentum of the Atmosphere: roles of divergence and rotational flow. 1
3. The Global Hadley and Ferrel cells: Observations and one theory.
4. Stationary waves: Observations.
5. Stationary waves: Theory of Zonal and Meridional Propagation.
6. Stationary waves: Theory of Vertical Propagation.
7. Mid-latitude Transient fluctuations, Part I.
8. Life Cycles of Baroclinic Instability. Part I : Theory
   Life Cycles of Baroclinic Instability. Part II: The experiments.
   Life Cycles of Baroclinic Instability. Part III: Available Potential Energy.
9. Mid-latitude Transient fluctuations, Part II.
10. Global Barotropic Instability.
11. Introduction to Equatorial Waves.
12. Simple Theory of Forced Tropical Stationary Waves.
13. Eddy-Zonal Flow interactions.
14. Introduction to Stratospheric Circulation.
15. The mean meridional circulation in the stratosphere: Brewer-Dobson Circulation.
16. Introduction to Scale Interactions and the atmospheric spectrum
17. Preferred, Recurrent and Persistent States in the atmosphere

Academic Integrity

The homeworks and are designed to be undertaken independently. You may discuss your ideas with others and conference with peers on drafts of the work. However it is not appropriate to give your paper to someone else to revise. You are responsible for making certain that there is no question that the work you hand in is your own. If only your name appears on an assignment, your professor has the right to expect that you have done the work by yourself, fully and independently.
The course projects may be done in teams, but it should be made very clear to the professor and the rest of the class what the responsibility of each student was. Please see the University Honor Code